Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Expanding Flexible Use of the 3.7 to 4.2 GHz Band	)	GN Docket No. 18-122
	)	
	)	
Petition for Rulemaking to Amend and Modernize Parts 25 and 101 of the Commission's Rules to Authorize and Facilitate the Deployment of Licensed Point-to-Point Fixed Wireless Broadband Service in the 3.7-4.2 GHz Band	)	RM-11791
	)	
	)	
Fixed Wireless Communications Coalition, Inc., Request for Modified Coordination Procedures In Band Shared Between the Fixed Service and the Fixed Satellite Service	)	RM-11778

COMMENTS OF ERICSSON

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Ericsson submits these comments in response to the Notice of Proposed Rulemaking ("*NPRM*") in the above-captioned proceeding to make all or part of the 3.7-4.2 GHz band available for 5G, Internet of Things ("IoT"), and other advanced wireless services.[1]

I. INTRODUCTION AND SUMMARY.

Ericsson applauds the commitment by the Administration and the Federal Communications Commission ("Commission" or "FCC") to continue to foster U.S. leadership in 5G. As the recent Presidential Memorandum for a National Spectrum Strategy stated, the high-

[1] *Expanding Flexible Use of the 3.7 to 4.2 GHz Band*, Order and Notice of Proposed Rulemaking, FCC 18-91 (rel. July 13, 2018) ("*NPRM*").

capacity, low-latency, and high-speed capabilities of 5G "can unleash innovation broadly across diverse sectors of the economy[.]"[2] And, as Chairman Pai recently noted, "[s]eizing the opportunities of 5G is not incidental, but central to our ability to grow our economy, create new jobs, and unleash new services and applications that will raise our standard of living."[3] Prompt and appropriate action in this proceeding will do much to advance this national priority.

Ericsson is committed to doing its part to make 5G a reality for American consumers and industry, and to that end Ericsson is boosting its U.S. investments in R&D and manufacturing to support accelerated 5G deployments.[4] Through its ASIC Design Center in Austin, TX that focuses on 5G base stations and a new software development center charged with addressing the baseband technology needed for 5G, Ericsson is speeding the timeline to make 5G products available in the United States. Ericsson has begun manufacturing in the United States and will produce the first next-generation radios before the end of 2018.[5] This series of strategic initiatives will allow Ericsson to operate even closer to its customers, meeting the growing demand for 5G in the U.S. and globally.

A successful strategy for 5G requires access to mid-band spectrum, which offers a balance of low-band capabilities (favorable signal range and indoor penetration) and higher-band

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[2] *See* Presidential Memorandum on Developing a Sustainable Spectrum Strategy for America's Future, Section 1 (issued Oct. 25, 2018), https://www.whitehouse.gov/presidential-actions/presidential-memorandum-developing-sustainable-spectrum-strategy-americas-future/.

[3] Remarks of FCC Chairman Ajit Pai at the 7th Annual Americas Spectrum Management Conference, National Press Club, Washington, D.C. (Oct. 3, 2018), https://docs.fcc.gov-/public/attachments/DOC-354392A1.pdf.

[4] *See* Press Release, Ericsson, *Ericsson increasing US investments to support accelerated 5G deployments* (Aug. 10, 2018), https://mb.cision.com/Main/15448/2589865/889576.pdf.

[5] *Id.*

benefits (increased capacity for faster speeds and lower latency).[6] Other countries are already taking action to make substantial amounts of mid-band spectrum available for 5G, and it is important for the United States to act quickly.[7] There are, however, only limited opportunities to repurpose a large block of mid-band spectrum – in fact, the 3.7-4.2 GHz band is *the* critical opportunity for macro 5G deployment in mid-band spectrum.

Accordingly, Ericsson recommends that the Commission take the following steps:

- *Act quickly on this important mid-band opportunity.* At this point, the 3.7-4.2 GHz band is the only mid-band spectrum opportunity that has been identified as potentially suitable for an exclusive-use, flexible-rights, licensed service, with a sufficient amount of spectrum for macro 5G operations.

- *Repurpose hundreds of megahertz of 3.7-4.2 GHz spectrum.* An individual carrier will need access to somewhere on the order of 100 megahertz of spectrum if it is to achieve gigabit-level speeds for mobile broadband service.[8] To accommodate multiple carriers, the Commission must repurpose hundreds of megahertz of spectrum within the 3.7-4.2 GHz band. Ericsson notes that there is currently *no* licensed mid-band spectrum with channel sizes approaching anywhere near 100 megahertz.

- *Require stakeholders to ensure continued delivery of C-Band traffic or otherwise create incentives for earth station operations to clear the band.* Repack the band and transition C-Band traffic to alternative delivery mechanisms, for example via fiber or Ku-Band spectrum. Further, the Commission should sunset the few fixed point-to-point operations in the 3.7-4.2 GHz band.

- *Adopt a flexible use licensing framework for the 3.7-4.2 GHz band that is based on exclusive-use, geographic area licenses with allowances for new classes for transportable devices.* Fixed point-to-multipoint services should be permitted under the flexible use licensing terms adopted here. The Commission should also add a "transportable" class of devices that will enable more fixed uses.

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[6] Comments of Ericsson, GN Docket Nos. 18-122 & 17-183, at 1-2 (filed May 31, 2018) ("Ericsson MOBILE NOW Comments").

[7] *See NPRM* ¶ 6 (discussing international efforts to make mid-band spectrum available for 5G).

[8] *See* Letter from Mark Racek, Senior Director – Spectrum Policy, Ericsson, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 17-183, (filed Mar. 29, 2018) ("Ericsson Mar. 29, 2018 Letter").

- *License the spectrum on an unpaired basis.* This would make the band suitable for the use of TDD technology consistent with industry plans across the world.

- *Adopt the power and out-of-band emission limits proposed in the section below.* Ericsson generally supports the Commission's proposals.

II. THE 3.7-4.2 GHz BAND OPPORTUNITY IS VITAL TO U.S. SUCCESS IN THE GLOBAL RACE TO 5G.

A. Ericsson's *Mobility Report* Confirms Massive Growth in Mobile Broadband, Including the Future of 5G.

Growing demand for mobile data will drive unprecedented growth in mobile broadband services, including 5G. The June 2018 *Ericsson Mobility Report* forecasts that nearly half (48 percent) of all mobile subscriptions in North America will be 5G by 2023.[9] The *Ericsson Mobility Report* also found that North America continues to have the highest monthly data traffic per smartphone, reaching 7.2 gigabytes in 2017, and this figure is expected to rise to 49 gigabytes by the end of 2023.[10] And, by 2023, total mobile data traffic in North America is expected to exceed 19 exabytes per month (roughly eight times last year's traffic).[11] Not surprisingly, U.S. wireless operators have concluded that "expectations for long-term mobile data traffic outweigh the capacity that can be provided with existing spectrum holdings."[12] Or,

[9] Ericsson, *Ericsson Mobility Report*, at 11 (June 2018) ("*Ericsson Mobility Report*"), https://www.ericsson.com/assets/local/mobility-report/documents/2018/ericsson-mobility-report-june-2018.pdf.

[10] *Id.* at 14.

[11] *Id.* at 15.

[12] GSMA, *The 5G era in the US*, at 34 (2018) ("*GSMA 5G Report*"), https://www.gsma-intelligence.com/research/?file=4cbbdb475f24b3c5f5a93a2796a4aa28&download.

as Chairman Pai put it, "we're gonna need a bigger boat."[13] Expedited repurposing of the 3.7-4.2 GHz band is the next logical step towards addressing this challenge.

B. Mid-Band Spectrum Offers Unique Coverage and Capacity Characteristics for 5G.

While the Commission has made substantial strides towards making high-band spectrum and low-band spectrum available, "the opportunity to round out and super charge 5G connectivity will rely on opening up mid-band spectrum waves."[14]

Mid-band spectrum provides an optimal blend of coverage and capacity and is well-suited for robust, wide-area macro 5G offerings. Lower frequency bands, such as those below 2 GHz, are an excellent fit for coverage and mobility and provide more uniform coverage in non-line-of-sight environments. Lower frequency bands are valuable for high aggregation of low bandwidth users, such as massive Machine Type Communications ("mMTC") and interactive communications. High-band frequencies above 24 GHz offer large bandwidths that provide ultra-high capacity and very low latency. High-band frequencies are optimal for short range, low latency, and very high capacity transmissions for enhanced mobile broadband ("eMBB"). There are fundamental trade-offs between capacity, coverage, and latency in a wireless network, and the frequency band can play a large role. Mid-band spectrum, available in wide bandwidths, offers a hybrid of coverage and capacity unavailable in the lower bands (where coverage is the primary benefit) or the higher bands (where capacity is the primary benefit).

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[13] Statement of Chairman Ajit Pai, *Expanding Flexible Use of the 3.7 to 4.2 GHz Band et al.*, Order and Notice of Proposed Rulemaking, FCC 18-91 (rel. July 13, 2018).

[14] Roslyn Layton, *The U.S. Must Move Quickly On Mid-Band Spectrum If It Wants To Lead In 5G*, Forbes (May 23, 2018), https://www.forbes.com/sites/roslynlayton/2018/05/23/the-us-must-move-quickly-on-mid-band-spectrum-if-it-wants-to-lead-in-5g/#40ee41e7462a.

In terms of coverage, for example, propagation characteristics in the mid-band provide for wide-area outdoor coverage and good building penetration as compared to millimeter wave ("mmW") bands that support shorter range transmissions and offer less capability to penetrate indoors. Mid-band deployments thus can use a smaller number of base stations aggregating traffic over larger areas, rather than the number of small cells that will be used to support mmW 5G deployments in areas where traffic density or use case characteristics justify addition of high capacity. In terms of capacity, some 5G use cases will demand significantly higher peak data rates for faster connections and low latency, and this will require wider channels than what is available in the lower bands.[15] Thus, the mid-band "is now the sweet spot of spectrum innovation."[16]

C. Across the Globe, Nations are Committed to Using Mid-Band Spectrum for 5G.

The *NPRM* highlights that other nations are vying to lead on 5G. As GSMA recently noted, "[c]ompared to 4G, more markets are set to be involved in early 5G deployments around the world."[17] And those early deployments will rely increasingly on mid-band spectrum.

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[15] *Ericsson Mobility Report* at 31; 4G Americas, *The Voice for 5G in the Americas; 5G Spectrum Requirements*, at 3 (Aug. 2015)), http://www.5gamericas.org/files/6514/3930/9262/4G_-Americas_5G_Spectrum_Recommendations_White_Paper.pdf.

[16] Bret Swanson, *The spectrum sweet spot: How mid-band waves will help power 5G wireless*, AEIdeas (June 29, 2018), https://www.aei.org/publication/the-spectrum-sweet-spot-how-mid-band-waves-will-help-power-5g-wireless/.

[17] *GSMA 5G Report* at 32.

For example, South Korea recently completed its 3.5 GHz auction,[18] and China's regulatory authority has committed to release 100 megahertz of mid-band spectrum per operator, with a focus on 3.4-3.6 GHz.[19] The Radio Spectrum Policy Group of the European Commission has issued a mandate to the European Conference of Postal and Telecommunications Administrations (CEPT) that the 3.4-3.8 GHz band will be the first primary band for 5G, and "[a] number of European governments are already taking actions to make parts of the band available for 5G."[20] And Japan's Ministry of Internal Affairs and Communications has released a consultation examining the 3.6-4.2 GHz band, as well as the 4.4-4.9 GHz band.[21]

In sum, as Chairman Pai observed, "[o]ther countries, especially China, are eager to seize these opportunities for themselves, confident that the first mover will claim the bulk of the benefits (as happened when the United States led on 4G)."[22] But the U.S. wireless industry has

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[18] Monica Alleven, *South Korea wraps 5G auction for 3.5, 28 GHz*, FierceWireless (June 20, 2018), https://www.fiercewireless.com/wireless/south-korea-wraps-5g-auction-for-3-5-28-ghz.

[19] CTIA, *The Global Race to 5G*, at 8 (Apr. 2018), https://api.ctia.org/wp-content/uploads/2018/-04/Race-to-5G-Report.pdf; Dylan Bushell-Embling, *China edges ahead in 5G race*, telecomasia.net (Apr. 17, 2018), https://www.telecomasia.net/content/china-edges-ahead-5g-race. *See also* Asha Keddy, *US must respond to increasing global competition*, The Hill (Sept. 6, 2018), https://thehill.com/opinion/technology/404405-us-must-respond-to-increasing-5g-global-competition ("A recent study by Deloitte states that 'China and other countries may be creating a 5G tsunami, making it near impossible to catch up.' Most critically, these nations are taking steps to open up bigger slices of the 'mid-band' spectrum to 5G. Doing so enables both the speed and range needed for networks based on this fast-emerging, next-generation technology.").

[20] *NPRM* ¶ 6.

[21] David Abecassis, Chris Nickerson, and Janette Stewart, *Global Race to 5G – Spectrum and Infrastructure Plans and Priorities*, at B-26, Analysys Mason (Apr. 2018), https://api.ctia.org-/wp-content/uploads/2018/04/Analysys-Mason-Global-Race-To-5G_2018.pdf.

[22] Ajit Pai, *5G is in reach. But only if we set the right policies.*, Wash. Post (Sept. 26, 2018), https://www.washingtonpost.com/opinions/5g-is-in-reach-but-only-if-we-set-the-right-

been and continues to be a global leader in commercial investments and preparations necessary for 5G deployment, and U.S. action in mid-band spectrum will advance U.S. interests in 5G. The FCC has been at the forefront of regulatory policy – and spectrum policy in particular – for decades, and this forward-thinking policymaking has contributed significantly to U.S. strength in the global telecommunications marketplace, despite the challenges in navigating the economics of deployment in such a vast nation. Looking ahead, insightful policy in the 3.7-4.2 GHz band, including a rapid repurposing of spectrum with the right incentives for private sector action, will ensure investment, innovation, and robust 5G deployment. We therefore urge the FCC to ensure access to as substantial an amount of mid-band spectrum as is possible, and in a manner that pays heed to developments in similar bands around the world.

D. In the United States, the 3.7-4.2 GHz Band is the Only Mid-Band Spectrum Opportunity for Macro 5G.

At this point, the 3.7-4.2 GHz band is the only mid-band spectrum opportunity that has been identified in the United States as potentially suitable for an exclusive-use, flexible-rights, licensed service, with a sufficient amount of spectrum for macro 5G operations. The Commission appears focused on the 5.925-7.125 GHz (6 GHz) band for unlicensed use, and Ericsson continues to urge policymakers to explore part of the 6 GHz band for mid-band licensed operations. Ericsson also urges policymakers to consider a longer term approach to the 7-24 GHz band range for additional flexible-rights licensed spectrum; without such a long-term approach, the Commission risks undermining the United States' ability to address the increasing demand for mid-band spectrum. But to date, the 3.7-4.2 GHz band is the only mid-band spectrum that could be successfully repurposed for macro 5G deployments.

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policies/2018/09/26/9d5c322e-c1c7-11e8-8f06-009b39c3f6dd_story.html?utm_term=.93c577a5f57b.

While Ericsson supports the Commission's 3.5 GHz Citizens Broadband Radio Service ("CBRS") – and applauded the recent Report and Order modifying the Priority Access Licenses ("PALs") to enhance investment and innovation in the band – the rules continue to limit the 3.5 GHz band's utility for macro 5G deployments. Among them, as the Report and Order recently observed, the transmit power levels are "significantly lower" than in other bands due to coexistence concerns.[23] Further, a maximum of 70 megahertz will be available for the licensed PALs service, and a single entity is limited to holding no more than 40 megahertz of PALs spectrum in a market.[24] With its sharing arrangement, lower transmit power, and narrower channelization, the CBRS spectrum offers different capabilities and opportunities compared with the 3.7-4.2 GHz band.

Finally, repurposing the 3.7-4.2 GHz band will position the United States within a reasonable tuning range for harmonized mid-band 5G spectrum with much of the rest of the world, as the band overlaps and is adjacent to the mid-band spectrum that many nations are making available. Global harmonization results in a broader ecosystem for technology, equipment and engineering expertise, leading to economies of scale, lower costs for deployment, more rapid roll-out of new services, and enhanced competition among suppliers to the United States and global markets. Global harmonization thus remains integral to the continued growth of the mobile industry. These benefits, plus the need to maintain U.S. leadership in the race to 5G, put a premium on near-term Commission action in this proceeding.

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[23] *Promoting Investment in the 3550-3700 MHz Band*, Report and Order, FCC 18-149 ¶ 65 (rel. Oct. 24, 2018).

[24] In addition, GAA users will be able to use the PAL spectrum when not in use by PAL licensees.

III. A SUCCESSFUL 5G MID-BAND STRATEGY REQUIRES REPURPOSING HUNDREDS OF MEGAHERTZ OF 3.7-4.2 GHz BAND SPECTRUM.

Some 5G mobile broadband use cases will require network speeds of 1 gigabit per second and such speeds necessarily demand wide channel bandwidths – on the order of 100 megahertz.[25] Accordingly, the Commission should set a minimum nationwide spectrum benchmark in the hundreds of megahertz so that multiple competitors may acquire mid-band spectrum for macro 5G.

Ericsson commends the C-Band Alliance's recent proposal to transition 200 megahertz of spectrum, comprising 180 megahertz of usable spectrum plus a 20-megahertz guard band, as a step in the right direction.[26] But under any repurposing mechanism, the Commission should make sure that hundreds of megahertz of usable spectrum is transitioned for 5G and other next-generation services as quickly as possible. Ericsson does not favor a transition in which the majority of spectrum remains designated for satellite use; we would like to see the vast majority if not all of the 3.7-4.2 GHz band repurposed for licensed mobile broadband use. Ericsson urges the Commission to repurpose the maximum amount of spectrum for flexible use service from

[25] *See* Comments of Qualcomm Incorporated, GN Docket No. 17-183, at 5 (filed Oct. 2, 2017) ("The FCC should auction flexible use licenses with wide channelization (*e.g.*, 100 MHz for increased performance by leveraging 5G's inherent ability to use wide channels) . . . ."); Haig Sarkissian, *Analyst Angle: What spectrum bands will US operators use for Mobile 5G?*, RCRWireless News (Dec. 22, 2017), https://www.rcrwireless.com/20171222/analyst-angle/analyst-angle-what-spectrum-bands-will-us-operators-use-for-mobile-5g-Tag10 ("We consider a spectrum band to be suitable for 5G deployment if it consists of a minimum of 100 MHz of bandwidth because to deliver speeds close to 1 Gbps, 100 MHz will be needed if an efficient modulation scheme is used that produce[s] 10bits/Hz, assuming TDD technology.").

[26] C-Band Alliance, *C-Band Alliance Proposal Fact Sheet: October 22 Update*, at 1 (Oct. 19, 2018), https://c-bandalliance.com/wp-content/uploads/2018/10/20181022-200-MHz-FactSheet-Clean-and-Final.pdf.

day one, given the benefits in terms of economy of scale and availability of devices; clearing spectrum in multiple stages creates equipment complexities.

IV. REPURPOSING 3.7-4.2 GHz SPECTRUM WILL REQUIRE CLEARING INCUMBENT OPERATIONS.

A. Same-Market Sharing Between Earth Stations and Terrestrial Flexible Use Licensees is Not Practical for Co-Channel Operations and Will Involve Tradeoffs for Adjacent Band Operations.

As we stated before, Ericsson is not optimistic that large-scale co-channel sharing among wireless broadband systems and C-band earth stations is achievable or prudent, but the Commission and stakeholders should continue to develop adjacent channel sharing solutions. In 2017, Ericsson performed a study (submitted in the GN Docket 17-183 record) showing the need for large separation distances that would make any co-channel sharing approach of limited utility.[27] Specifically, Ericsson's analysis concluded that at least 30 kilometers of separation (best case scenario), and potentially as much as 50-70 kilometers of separation (less favorable conditions), would be required for co-channel coexistence between a terrestrial wireless base station and a C-band earth station using the same spectrum.[28] While some sharing could occur on a limited basis, as Ericsson concluded at the time, such large separation distances "eliminate[] possibilities for co-channel sharing in the populated areas."[29]

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[27] *See* Ericsson, Co-Channel Sharing Assessment ("Ericsson 3.7-4.2 GHz Co-Channel Sharing Assessment"), *appended as* Att. A to Comments of Ericsson, GN Docket No. 17-183 (filed Oct. 2, 2017).

[28] Ericsson 3.7-4.2 GHz Co-Channel Sharing Assessment at 1, 3. Other data in the record from both terrestrial and satellite interests confirm that sharing spectrum in the band would be extremely challenging, and that significant separation distances would be needed between terrestrial mobile base stations operating co-frequency with C-band earth stations. *See* Ericsson MOBILE NOW Comments at 4-5, nn.12-13 and the comments cited therein.

[29] Ericsson 3.7-4.2 GHz Co-Channel Sharing Assessment at 3.

Ericsson also submitted a preliminary study on the feasibility of adjacent channel sharing between terrestrial wireless base stations and C-band earth stations.[30] This study indicated that adjacent channel sharing between broadband transmitters and earth station receivers was feasible in the 3.7-4.2 GHz band. Specifically, Ericsson determined that the interference from the base station towards the satellite earth station in the adjacent channel scenario is expected to meet the interference thresholds (*i.e.*, Interference-to-noise ratio) at the satellite receiver with various mitigation techniques such as separation distances, lower transmit power in adjacent frequencies or in some cases guard bands.

Ultimately, adjacent band coexistence of broadband and satellite earth stations in the 3.7-4.2 GHz band depends on the relationship and tradeoffs associated with multiple parameters and assumptions used to analyze compatibility. These factors include unwanted emission limits, antenna height, elevation angle to the satellite, separation distance, guard band, propagation, and mitigation assumptions. For successful co-existence, these parameters are inter-dependent, and thus decisions must be informed by appropriate study and analyses to understand the relationships between these parameters. Below we address these parameters, and how each could impact the compatibility scenario between broadband transmitters and earth station receivers.

Out of Band Emissions. In the *NPRM*, the Commission proposed to apply the longstanding limit on out of band emissions of -13 dBm/MHz at the authorized channel edge.[31]

[30] *See* Ericsson, Adjacent Channel Sharing Assessment at 1, *appended as* Att. A to Ericsson MOBILE NOW Comments.

[31] *NPRM* ¶ 168.

The Commission sought comment on whether it is necessary to adopt more stringent out of band emission limits beyond the edges of the band.[32]

Ericsson's preliminary study on the feasibility of adjacent channel sharing used an unwanted emission level of -13 dBm/MHz as proposed by the Commission. Further analyses are necessary to consider the advantages and disadvantages of adopting a lower out of band emission limit at the FSS earth station receive band edge (*i.e.*, a multi-plateau emission mask).

Antenna Height. Differential antenna height (*i.e.*, where the earth station antenna is located significantly higher than the broadband base station antenna) would help increase the likelihood that broadband and earth station operations can coexist in adjacent (or nearby) spectrum at closer separation distances. This is due to the high level of antenna discrimination from the very directional earth station antenna, combined with the fact that base station antennas are often downtilted in order to serve customers located below the base station antenna. In dense urban areas (downtown), earth stations positioned on rooftops can significantly reduce potential interference.

Elevation Angle. Optimal performance is achieved when earth station antennas are operating at the highest elevation angle possible. Antenna discrimination increases as the angular separation between the mainbeam of the earth station and the interference source increases. Earth stations operating with satellites that are at low elevation angles (*i.e.*, close to the horizon) are more likely to receive interference from terrestrial sources.

Mitigation. A critical factor for the Commission to consider is what methods are available to mitigate any potential interference. There are steps that can be taken at a local level to ensure compatibility, such as shielding FSS earth stations from interfering signals, locating

[32] *Id.* ¶ 169.

FSS earth station antennas in locations that are less heavily used for delivering broadband services, and possibly others.

Separation Distance. Increased separation distance between the broadband base station and the earth station increases propagation losses, and also increases the likelihood that some object or terrain will reduce energy toward the earth station. The disadvantage of increasing separation distance is that broadband coverage will be negatively impacted.

Guard Band. A guard band will help to reduce the impact on adjacent band services, but also results in valuable spectrum lying fallow. One goal of the Commission should be to minimize the use of any guard band necessary to ensure compatibility between broadband and FSS services.

The Commission must weigh the tradeoffs associated with these types of parameters, and should take deliberate actions based on the record developed in this proceeding. Accordingly, Ericsson is ready and eager to work with the satellite community to optimize geographic separation requirements, consider any appropriate guard band requirements, and work on other parameters described above to maximize spectrum for 5G deployments and coverage. Ericsson will continue to examine the scenarios under which broadband and FSS can coexist, and will keep the Commission informed about the tradeoffs between these various system attributes.

B. Today's C-Band Traffic Can Be Delivered in a Smaller, Repacked Band and by Alternative Paths Such As Fiber and Ku-Band Spectrum.

The Commission can repurpose significant 3.7-4.2 GHz spectrum while ensuring that traffic that currently is delivered via C-band earth stations is still provided. First, earth stations can be repacked into a portion of the C-band given the excess capacity that exists today. As Ericsson previously demonstrated, only 37 percent of C-band satellites have any significant transponder usage, and transponder equivalent ("TPE") demand is expected to decline by 26

percent over the ten year period from 2017 through 2026.[33] These factors alone should free up significant 3.7-4.2 GHz spectrum.

The Commission should also identify a variety of options for transitioning current C-Band earth station traffic to alternative means of delivery, including another transmission medium (fiber or wireless broadband, e.g., 5G) or other spectrum (e.g., Ku-band). Alternatively, C-band operations could be moved to more remote areas subject to interference protection, using various backhaul options to the destination point.[34] While Ericsson expects these issues to be primarily a matter of private negotiation, the Commission should ensure that all concerned parties know what options are appropriate and when band clearing must take place. An investment climate conducive to the deployment of 5G services requires assurance that enough spectrum will be cleared by a certain time, and existing earth station users should know that their concerns will be addressed.

Ericsson believes there may be opportunities for the Commission to facilitate an arrangement where incentives are offered to the earth station operators *en bloc* to transition operations away from or out of the mid-band spectrum. Such participation would be voluntary and based on a negotiated valuation for relinquishing licenses that are already held. Widespread interest in such offers may make it significantly easier for remaining FSS users to be repacked to the upper end of the band.

[33] Ericsson Mar. 29, 2018 Letter at 2.

[34] Letter from Steve B. Sharkey, Vice President, Government Affairs Technology and Engineering Policy, T-Mobile USA, Inc., to Marlene H. Dortch, Secretary, FCC, GN Docket Nos. 17-183 & 18-122 (filed June 15, 2018).

C. The Commission Should Sunset Fixed Point-to-Point Links in the Band.

Ericsson agrees that the Commission should sunset fixed point-to-point use of the 3.7-4.2 GHz band as quickly as possible.[35] As the Commission notes, fixed point-to-point use of the band has declined sharply as common carrier and private operational fixed licensees have migrated to fiber or to alternative frequency bands that offer superior channelization and entail no risk of interference to satellite incumbents.[36] Similar fiber or alternative spectrum options are available to the relatively small number of fixed point-to-point licensees remaining in the band.

These steps will provide clarity, as operators, vendors and investors in 5G need certainty as to how many incumbents will need to be cleared, and how many will be sunset, in the 3.7-4.2 GHz band *ahead* of 5G deployment.

V. SERVICE RULES SHOULD FOSTER 5G INVESTMENT, INNOVATION, AND RAPID DEPLOYMENT.

A. An Exclusive-Use, Flexible-Rights Licensing Framework Should Enable New Opportunities in the Band, Rather than Adoption of a Dedicated Fixed Point-to-Multipoint Service.

Ericsson supports the Commission's proposal to license the 3.7-4.2 GHz band under its flexible use, Part 27 rules that permit licensees to provide any fixed or mobile service, subject to rules necessary to prevent or minimize harmful interference.[37] As the Commission has previously stated:

> [F]lexibility will promote broadband deployment, ensure the spectrum is put to its most beneficial use, and maximize the probability of success for new

[35] *NPRM* ¶ 48.

[36] *Id.* ¶ 47.

[37] *Id.* ¶ 133.

> services. . . [W]e expect that flexibility will allow any licensee . . . '[to] maximize the value of the spectrum resource both to the licensee and the public.'[38]

This is particularly true for 5G services, which promise to deliver innovative new high speed, low latency offerings.

Ericsson does not, however, support introduction of a new, dedicated fixed point-to-multipoint ("P2MP") service into the 3.7-4.2 GHz band prior to any flexible-use services.[39] As an initial matter, the flexible use licenses envisioned here will allow the introduction of fixed wireless broadband offerings, so there is no need to establish a dedicated service. P2MP use would be allowed under the same flexible use licenses that allow mobile broadband. Authorizing a dedicated P2MP service in the 3.7-4.2 GHz band would add encumbrances and, even if limited to the repacked band, would restrict the Commission's ability to repurpose that spectrum if necessary at a later juncture for mobile broadband use.[40]

B. Block Size Should Permit Licensees' Ability to Acquire on the Order of 100 Megahertz Holdings.

The Commission seeks comment on "appropriate [channel] block size to promote efficient and robust use of the [3.7-4.2 GHz] band for next generation wireless technologies,

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[38] *Service Rules for Advanced Wireless Services in the 2000-2020 MHz and 2180-2200 MHz Bands*, Report and Order and Order of Proposed Modification, 27 FCC Rcd 16102, 16187 ¶ 224 (2012) (citations omitted). Ericsson also supports exclusive, geographic licensing of the 3.7-4.2 GHz band, using licensing areas that are less than nationwide. *See NPRM* ¶ 138.

[39] *See NPRM* ¶ 118 (requesting comment on amending Section 101.101 to permit P2MP fixed service in "some portion of the 3.7-4.2 GHz band").

[40] *Id.* ¶ 119 ("[W]e seek comment on making available for point-to-multipoint use 40 megahertz, 100 megahertz or up to 320 megahertz.").

including 5G."[41] The spectrum should be licensed in a way that enables the promise of 5G, including network speeds of 1 gigabit or better – which requires on the order of 100 megahertz channels.[42] To facilitate clearing of earth stations, we propose that block sizes should be either 40 or 50 MHz blocks that allow the carrier to acquire 100 megahertz of spectrum. The 40 megahertz is derived from the overlap of the fixed 2x20 megahertz channels, the TPE bandwidth being ~40 megahertz, and the 3GPP standards that support 40 megahertz or 50 megahertz blocks. It is important to note that the channel block size should not dictate the outcome of the amount of spectrum that could be acquired by each carrier.

C. License Blocks Should Be Unpaired.

The Commission should license the 3.7-4.2 GHz band on an unpaired basis, and thereby enable licensees to utilize Time Division Duplex ("TDD") technology. Under TDD, downlink and uplink transmissions are carried over the same frequency but at different times. The lack of a defined duplex gap separating uplink and downlink provides the flexibility to operate in any portion of the band within the specified frequency range. TDD networks can be especially beneficial in cases of asymmetric traffic, *e.g.*, user streaming. In addition, to avoid adjacent channel interference and make an optimal use of spectrum, we recommend a general baseline of synchronization among operations in adjacent channels within the C-band, recognizing that this may not be necessary in certain deployment scenarios.

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[41] *Id.* ¶ 135.

[42] *See* Ericsson Mar. 29, 2018 Letter.

VI. REASONABLE TECHNICAL RULES CAN ENABLE THE PROMISE OF 5G.

A. Power Limits.

For fixed and base stations in the 3.7-4.2 GHz band, Ericsson would accept the Commission's proposed power limits of 1640 watts EIRP for emission bandwidths less than one megahertz, and 1640 watts per MHz (62 dBm/MHz) EIRP for emission bandwidths greater than one megahertz.[43] Ericsson further supports doubling these limits (*i.e.*, to 3280 watts EIRP or 3280 watts/MHz) in rural areas.[44] These levels are commensurate with existing rules and deployments, and the higher power limit for rural areas may promote rural deployment of broadband services.

The Commission, however, should refrain from imposing a 75 dBm EIRP limit on the total power of a base station, summed over all antenna elements, for fixed and base stations.[45] Instead, to ensure deployment of viable macro networks consistent with the existing LTE grid, at 3.7-4.2 GHz, Ericsson recommends that the Commission impose no limit on total power other than the power density limit.

Ericsson believes that the Commission should add a "transportable" class of devices, consistent with its findings in the UMFUS proceeding. There, the Commission allowed 55 dBm EIRP for such transportable devices.[46] The Commission found that such higher power will increase range, enable higher data rates, and provide for better coverage throughout buildings so

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[43] *NPRM* ¶ 164.

[44] *Id.*

[45] *Id.* ¶ 165.

[46] *Use of the Spectrum Bands Above 24 GHz For Mobile Radio Services*, Report and Order and Further Notice of Proposed Rulemaking, 31 FCC Rcd 8014, 8114 ¶ 286 (2016) ("*UMFUS Order*").

that consumers will have flexibility in installation locations to provide service where needed. These benefits would also translate to mid-band spectrum. Ericsson also believes that such a category of device will have important industrial and utility applications as well. Accordingly, Ericsson proposes that the Commission should adopt rules to allow such transportable devices to be operated in the 3.7-4.2 GHz band as well as in the UMFUS bands.

As to mobile and portable units, Ericsson accepts the Commission's proposal to limit power to 1 Watt (30 dBm) EIRP.[47] The Commission notes in the *NPRM* that this level is within the range of power levels permitted for mobile devices in other mobile broadband services, and Ericsson expects that it will provide sufficient performance for the services envisioned for the 3.7-4.2 GHz band.[48]

B. Out-of-Band Emissions.

Ericsson generally supports the Commission's proposal to apply its longstanding limit on conducted emissions (-13 dBm/MHz) to the 3.7-4.2 GHz band.[49] We note, however, that future mobile systems are going to increasingly rely on large arrays of active antenna elements in their design, which the Commission should take into account.

The use of antenna arrays allows adaptive beamforming, and there is a tradeoff between MIMO and beamforming that usually seeks to improve the bit rate sustained by the channel, nominally by improving received signal power with respect to the interference, and further by division of energy between multiple separable modes of the channel. In such systems, Ericsson

[47] *NPRM* ¶ 167.

[48] *Id.*

[49] *Id.* ¶ 168.

supports the use of Total Radiated Power ("TRP") as an alternative desirable metric for advanced antenna array systems.[50]

TRP requires that the sum of all emissions from all transceivers in the advanced antenna array should be kept below the required unwanted emission level, and in practice the level of unwanted emissions per transceiver in the antenna array would need to be kept 10·log10(n) dB lower (where n is the number of transceivers) than the required unwanted emission level.

In the alternative, Ericsson would also support the option of using "conducted equivalent" measurements, which is similar to TRP as both metrics correspond to a similar unwanted emission requirement. The Commission adopted TRP as an alternative to a conductive measurement in the UMFUS.[51]

At the band edge for FSS earth station receive operations (*i.e.*, at the edge between the guard band and earth station receive operations), the Commission should consider a conductive power level or total radiated power level of -40 dBm/MHz, assuming a guardband on the order of 25 megahertz to enable a reasonable separation distance. Again, as discussed above, these factors, together with others such as filtering capabilities, earth station elevation angle, and antenna height, all play into adjacent channel broadband-FSS earth station co-existence. And, at the band edge adjacent to CBRS, the conductive power or the total radiated power of any emission should be -13 dBm/MHz, with appropriate compatibility with emission rules needed for incumbent protection for FSS and the three terrestrial radar sites within the CBRS band. As noted, Ericsson is eager to work on these issues with stakeholders in this proceeding.

[50] Comments of Ericsson, GN Docket No. 14-177, at 14-15 (filed Jan. 26, 2016).

[51] *UMFUS Order*, 31 FCC Rcd at 8120-21 ¶ 303.

C. Field Strength Limits/Market Boundaries.

The Commission will need to ensure that 3.7-4.2 GHz licensees do not cause interference to co-channel systems located in adjacent license areas. For this purpose, we agree that the -76 dBm/m^2/MHz power flux density limit that the Commission adopted for the UMFUS services is preferred as an appropriate limit for the 3.7-4.2 GHz band.[52]

VII. CONCLUSION.

Ericsson urges the Commission to promptly act in this rulemaking to advance U.S. prospects for macro 5G deployments by making mid-band spectrum available quickly.

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[52] *NPRM* ¶ 184.